INDIAN BROOK STORMWATER MANAGEMENT EVALUATION

Prepared For:
Lake Champlain Basin Program
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PART 2: Individual Watershed Stormwater Management Evaluations

The findings of this project are presented in the following individual watershed evaluations. The intent of reporting results in watershed format is to facilitate the incorporation of these findings into comprehensive watershed management plans for each of the project watersheds. These evaluations are not comprehensive management plans and should not be viewed as such. The intent is for these evaluations to serve to focus planning efforts and to provide a basis for evaluating specific implementation activities that will most likely result in environmental benefits in the form of minimized pollutant loadings to the target watersheds and to Lake Champlain and restoration of impaired riparian and aquatic habitat and the biologic communities that those habitats support. Above all, it is the hope of this project that these findings will stimulate the development of comprehensive multi-jurisdictional watershed planning efforts within the project area, resulting in watershed management conducted across political boundaries with full investment by local and regional authorities.

This project has assembled and/or created a number of Geographical Information System (GIS) data layers relevant to watershed planning in the project area (see Part I). Information from these data layers is presented in a series of figures attached to each watershed evaluation. These data layers with their associated data tables, will be available to local and regional planners. It should be recognized that the pollutant projections presented here are planning estimates and caution should be exercised when interpreting these values.

This project recognizes that local governments in the project area have made tremendous commitments to protecting and preserving the natural resources associated with surface waters. Local and regional planning, zoning, and conservation commissions have established a strong record of environmental concern. In order to fully realize effective watershed management, it is critical that individual missions, goals, objectives, and policies be consolidated under the umbrella of comprehensive watershed planing and management. It is hoped that the findings of this project will assist those responsible for planning and environmental management in the project area in their efforts to restore, protect, and preserve the aquatic resources of these highly vulnerable developing watersheds.

Indian Brook Stormwater Management Evaluation

Watershed Description

Indian Brook was named by the original settlers for the native Abenaki who had a campsite at the brook's mouth near Malletts Bay. The Indian Brook Reservoir was originally constructed as a public water supply in the late 19th century. The watershed including the heavily forested Indian Brook Park was converted from forest to agriculture in the 19th century. A saw mill and millpond were constructed at the Mill Pond Road crossing, the pond is still in existence. A large brick kiln works operated for over 100 years on the stream just east of Rte. 15 in Essex Junction. An indication of the wild nature of the stream is that maps at the end of the 19th century showed the stream joining with Crooked Creek (which it does not) and reaching Malletts Bay south of its actual location.

Indian Brook is a large watershed (30.63 km2) located about equally in the towns of Essex and Colchester **(Figure 5.1)**. The southwest part of the watershed is in the Village of Essex Junction. The stream rises in the hills surrounding Indian Brook Reservoir and Colchester Pond. The stream flows south and west through large wetlands to Malletts Bay. The Northern Brook Lamprey, an endangered species in Vermont, resides in the lower part of the watershed.

Land Use

In 1995 land use in the watershed was approximately 60% undeveloped mixed forest and agricultural cropland, 20% mixed residential, 15% commercial-industrial and 5% protected open space. Future land use projections are for land conversion to 15% subregional growth center, 40% mixed residential, 40% undeveloped forest-agriculture and 5% protected open space. The watershed is approximately 6% impervious **(Table 5-1)**.

Table 5-1. Indian Brook: Current and Projected Land Use as percent watershed area. Projected land use is indicated in terms of zoning or planning categories.

	Open Protected	Forest/Ag	Res/Dev	Com/Ind	Urban/ Mixed	Regional Growth Center	*Impervious Surface Area*
1995	5%	60%	20%	15%			6%
Projected	5%	40%			40%	15%	

Soils

Highly erodible soils (Hartland and Limerick) exist in the stream channel in the more developed southeast corner of the watershed. Release of these sediments by runoff should be controlled. Highly erodible soils also are present in the projected subregional growth center around the Laing Farm. Soils suitable for wetponds are rare but soils suitable for infiltration (Adams) are abundant in the Village of Essex Junction and also in the central area of the watershed currently becoming suburbanized **(Figures 5.3-5)**.

Riparian Corridor and Biological Evaluation

Evaluation of the riparian stream corridor indicates severe corridor degradation in Essex Junction. Habitat quality improves above and below the city although degradation reoccurs in the rapidly developing eastern side of the watershed **(Figure 5.6)**.

Sedimentation in Indian Brook is most severe between stream mileposts 7-9. Silt levels immediately below the northeast residential neighborhoods of Essex Junction village reach 50% of the total channel sediment fraction.

Fish community analysis in the entire reach between stream milepost 6-10 indicates a degraded community. Macroinvertebrate sampling at 4 sites indicates degradation from sediment and enrichment in the reach around the village. Overall aquatic health is poor with the exception of the reach at milepost 9.2-9.6 where the stream appears to recover. Indian Brook does not meet the Class B water quality standard for biological integrity between mileposts 7-9 **(Figure 5.7)**.

Watershed Management Goals

The following are watershed management goals suggested by the findings of this evaluation:

1. Have in place the appropriate watershed planning and management infrastructure for the Indian Brook watershed such that comprehensive watershed management issues become an integral part of local planning processes. Watershed management should emphasize stream buffer protection, land acquisition, and watershed restoration.

2. Ensure the maintenance and protection of any existing high quality biological communities and habitats, including all existing wetlands, natural areas, and natural heritage sites through appropriate planning.

3. Ensure the protection of endangered Northern Brook Lamprey populations in the lower reaches of the watershed.

4. Restore impaired aquatic and riparian habitat such that biological integrity consistent with Class B water quality standards is attained.

5. Establish consistent inter-jurisdictional (Essex, Essex Junction, Colchester) stormwater management and stream protection policies throughout the Indian Brook watershed.

6. Ensure that watershed residents are aware of watershed management issues and are well educated in the principles of stream and watershed protection.

7. Minimize the discharge of pollutants from stormwater discharges in the Indian Brook watershed.

Existing Zoning

A conservation floodplain buffer zone has been established for Indian Brook in Essex and Essex Junction. The zone as defined by the 100 year flood prohibits development; variances are granted. In addition, in Essex only, areas where no floodplain exists a 25' or 5x the stream width (whichever is greater) buffer exists. Agriculture is exempt from the zone. A buffer zone and municipal recreation/conservation area has been established around the Indian Brook Reservoir in the headwaters of the brook. Swimming and fishing are allowable uses in the reservoir. The lower 5.5 miles of the brook in Colchester also has a conservation floodplain-wetland buffer zone although none of the tributaries have this protection. The watershed has been zoned for residential and commercial land uses; Colchester alone has 6 subregional growth centers several of which overlap the stream corridor. A 50' setback is required in Colchester near all stream banks with a slope exceeding 45 degrees.

Additional watershed features, including wetlands, 100 yr floodplain, Natural Heritage sites, natural biological areas and public lands, are mapped on **Figure 5.8**. **Figure 5.9** shows mapped impervious surface, **Figure 5.10** shows sewershed outlines, and **Figure 5.11** shows nonpoint sources such as eroding banks and

storm drain outfalls, identified during the watershed survey.

Education Strategy

An education strategy for urban nonpoint source pollution should include the following actions: 1) informational mailings and public service announcements to watershed residents on clean stream habits, 2) public involvement in cleanup, erosion and habitat restoration projects, 3) storm drain stenciling, 4) school natural history programs and, 5) citizen monitoring (Drinkwin, 1995; Lake Champlain Committee, 1992).

Implementation Strategy

The brook has two targeted storm sewersheds: the Five Corners-North sewer and the Essex Junctional Educational Center storm drains **(Table 5-2, Figures 5.12-5.15)**.

A municipal land holding on the Educational Center property would provide an optimal site for a constructed storm water wetland (map 8; Part 1). Wetland restoration work began on this site in July 1996. The location of the site would allow capture of the targeted storm sewersheds and an additional 8 storm sewers discharging within a half mile upstream. Total annual TSS and TP reduction resulting from this implementation would be 4,530 kg (49%) and 7 kg (43%) respectively. With capture and treatment of the upstream sewers, pollutant reduction could potentially double. The estimated capital cost range for this regional wetland facility is $86,042-$1,376,674.

The Countryside Drive development has 4 separate storm sewer systems which cumulatively qualify for targeting but individually do not. It is listed here because of its impact on a biologically significant area of Indian Brook, but treatment options are not given.

There is one targeted permitted discharge: the Laing Farm Shopping Center. This permit currently discharges in part to a wetland. Modification to this site for complete wetland storm water treatment would result in a TSS reduction of 3520 kg/yr. Estimated capital cost for this modification is S78,755-$1,260,000. Because the site only requires modifications, the actual cost should be significantly lower than this estimate. The Laing Farm Shopping Center is expected to triple its existing impervious surface within the next several years. As with the Taft Corners area of Allen and Muddy Brooks this area is almost entirely subject to state storm water review. Water quality controls on storm water discharges should be included in permits issued for this subregional growth center.

With the recommended storm sewer BMP's, annual TSS and TP loading to Indian Brook from these stormwater sheds would be reduced by 56% and 46% respectively.

Implementation recommendations, estimated treatment efficiencies and loading reductions, and estimated capital and annualized capital costs are summarized in **Table 5-3.** Annualized capital costs for phosphorus and suspended solids loading reductions at individual sites range from $923 - $14,775 per kg/yr for phosphorus and $0.93 - $55 per kg/yr for suspended solids.

Recommendations: The following recommendations, deriving from the findings of this evaluation, are made as technical suggestions that, if implemented, have a high likelihood of positively influencing water quality goals for the watershed. They are not intended to replace the development of a fully comprehensive watershed management plan.

1. Clearly, the most significant recommendation that can be made here is for the establishment of a watershed planning process that will be able to incorporate the findings of this evaluation into a comprehensive watershed management plan. Such a plan would institutionalize stormwater and watershed management policies across political boundaries. Such a plan would also necessarily address the implementations issues such as prioritization and financing (Schueler, 1996).

2 Restoration of Impaired Habitat - The most highly impacted areas in the watershed occur in the vicinity of

Essex Junction and in the rapidly developing area around Laing Farm. Riparian and aquatic habitat in these areas are impaired. It is likely that measures to reduce the release of sediments and suspended solids to this portion of the watershed through riparian habitat restoration and BMP implementation at targeted sewersheds will result in improved habitat and biological integrity. Therefore:

- Additional feasibility studies for BMP implementation recommendations for targeted sewersheds **(Table 5-3)**, prioritized by estimated Total Suspended Solids loading **(Table 5-2)**, should be initiated (see implementation strategy).

- Efforts to reduce discharges from significant sources of nonpoint sediment, such as eroding or unstable banks identified by this **(Figure 5.11)** or other evaluations, should be pursued. Opportunities to implement stream and riparian habitat restoration and improvement activities should be fully explored. Programs such as the Youth Conservation Corps and the USFWS Partnership program are likely resources for implementing watershed restoration activities. Cooperative efforts between landowners and various State, private, and Federal Agencies should be encouraged and coordinated.

3. Coordination - Resources should be allocated to provide for coordination of activities, including the acquisition of implementation resources, related to urban watershed management. VTDEC and USEPA are currently funding a limited service position to provide this function. If multi-jurisdictional urban watershed management is to be effective in the future, this function must be maintained, ideally through institutionalized regional planning.

4. Watershed Monitoring - Continued monitoring of watershed condition should be conducted. BMP implementation effectiveness should be monitored. While VTDEC plans to maintain a minimal level of biological monitoring at many of the sites previously monitored, its resources are limited. Monitoring issues should be developed through the watershed planning process that should evolve at the regional or local level (Brown, 1996).

5. Education - A watershed management educational strategy should be developed and implemented for the Indian Brook watershed. Generalized materials related to watershed protection are available from various private and governmental organizations (Lake Champlain Committee, 1992; Drinkwin, 1995).

Indian Brook Resources

Indian Brook Reservoir Assessment. Author unknown. Date unknown. School of Natural Resources, University of Vermont, Burlington, VT.

Table 5-2. Targeted Stormwater Discharges in the Indian Brook Watershed: Discharges are targeted based on estimated exceedence of annual loading thresholds for: suspended solids (4,536 kg/year); total phosphorus (6.8 kg/year); total metals (5.4 kg/year); total PAHs (36 kg/year); fecal coliform (500,000 colonies/yr). Existing treatment structures are indicated. *Italics indicate stormwater discharges with VTDEC stormwater permits.* EIA% is the percent surface area as Effective Impervious Surface Area. Loadings are calculated from the means of ranges in export coefficients taken from the literature. See Part 1 of this report for loading calculation methods.

Recwater	Storm sewershed	Treatment (Appendix 4)	EIA%	Loading kg/yr
	Highest Total Suspended Solids **(Figure 5.13)**			
Indian	Five Corners-North	CB	56.9	5,687
Indian	*Laing Farm Shopping Center*	*CB/SB/WL*	55.2	5,029
Indian	Countryside Drive 1-4	CB	13.8	4,919
	Highest Total Phosphorus **(Figure 5.14)**			
Indian	*Laing Farm Shopping Center*			11
Indian	Countryside Drive 1-4			11
Indian	Five Corners-North			9
	Highest Total PAH (Commercial Landuses Only)			
Indian	*Laing Farm Shopping Center*			83
Indian	Five Corners-North			61
Indian	Essex Junction H.S. 1		70.6	38
	Highest Total Metals **(Figure 5.15)**			
Indian	Five Corners-North			7
Indian	*Laing Farm Shopping Center*			5
Indian	Countryside Drive 1-4			5

Table 5-3. Indian Brook Watershed: Stormwater BMP implementation treatment and capital costs estimates for targeted sewersheds. All estimates are based in a mean of a range of export coefficients for TP and TSS.

Rec. Wat.	Sewershed	BMP	TP Pre BMP kgs/yr	TP Post BMP kgs/yr	TP Reduction kgs/yr	TSS Pre-BMP kgs/yr	TSS Post-BMP kgs/yr	TSS Reduction kgs/yr	Capital Cost-Low dollars	Capital Cost-High dollars
Indian	EJ Edu Ctr 1	Wetland	6	3	3	3576	1073	549	$29,262	$468,188
Indian	Five Corners-North	Wetland	9	5	4	5687	1706	3981	$56,780	$908,486
Indian	Laing Farm	Wetland	11	6	5	5029	1509	3520	$78,755	$1,260,000
		TOTALS	26	14	12	14292	4288	8050	$164,797	$2,636,674

	Capital Costs/kg				*Annualized Capital Costs*					
Sewershed	TP Cost Low Dollars/kg	TP Cost High Dollars/kg	TSS Cost Low Dollars/kg	TSS Cost High Dollars/kg	Annual TP Costs $/kg 30 yrs @ 5% Low	Annual TP Costs $/kg 30 yrs @ 5% High	Annual TSS costs $/kg 30 yrs @ 5% Low	Annual TSS costs $/kg 30 yrs @ 5% High	Total Annualized Costs 30 Years @ 5% Low	Total Annualized Costs 30 Years @ 5% High
EJ Edu Ctr 1	$9,754	$156,063	$53	$853	$635	$10,152	$3.47	$55	$1,904	$30,456
Five Corners-North	$14,195	$227,122	$14	$228	$923	$14,775	$0.93	$15	$3,694	$59,098
Laing Farm	$15,751	$252,000	$22	$358	$1,025	$16,393	$1.46	$23.29	$5,123	$81,965
AVERAGE	$13,733	$219,723	$20	$328	$893	$14,293	$1.33	$21	$10,720	$171,519

Indian Brook

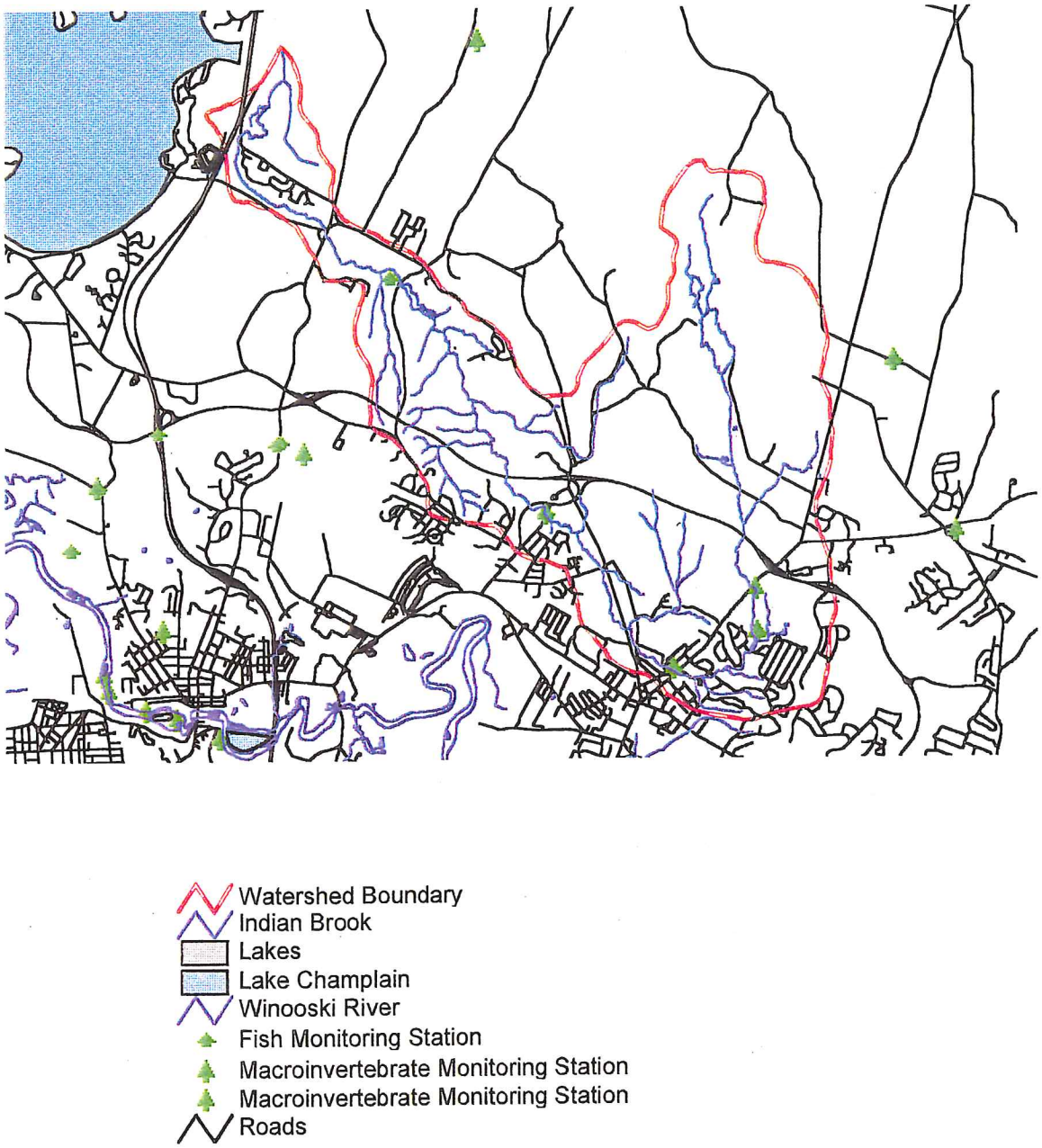
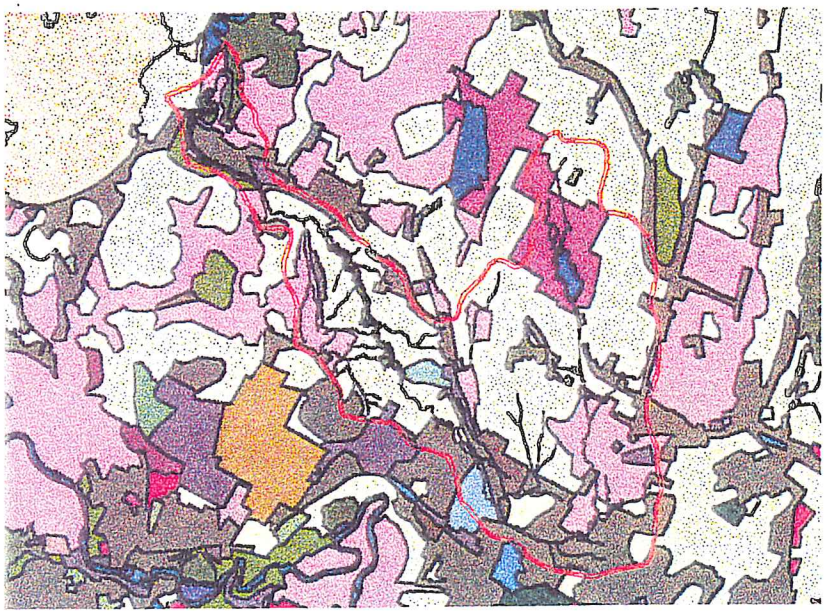
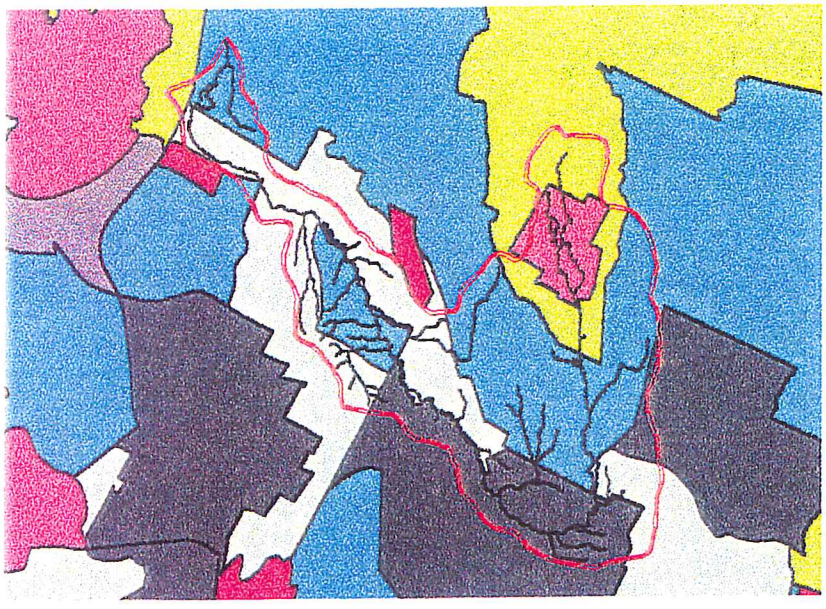


Figure 5.1: Indian Brook watershed showing roads and biological monitoring sites.





Indian Brook Watershed
Land Use 1995

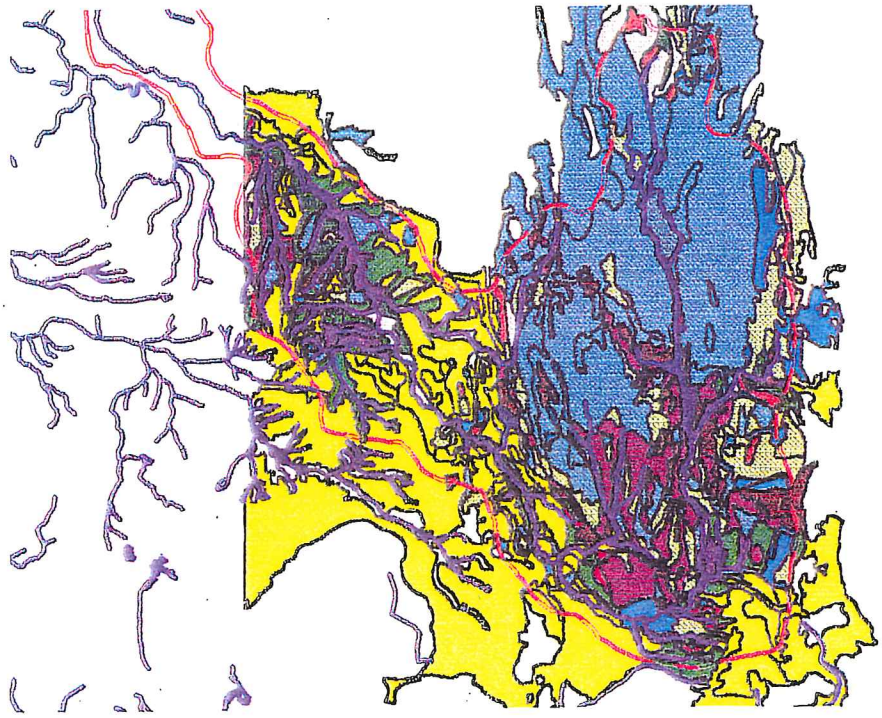
- 0
- 1100
- 1130
- 1190
- 1200
- 1210
- 1250
- 1252
- 1260
- 1270
- 1281
- 1300
- 1330
- 1370
- 1373
- 1400
- 1410
- 1412
- 1440
- 1460
- 1470
- 1480
- 1481
- 1482
- 1500
- 1510
- 1600
- 1700
- 1720
- 1730
- 1734
- 1735
- 1736
- 1737
- 1740
- 1790
- 2100
- 2200
- 2430
- 3000
- 3300
- 4100
- 4200
- 4300
- 5100
- 5200
- 5210
- 6000
- 6100
- 7200
- 7400

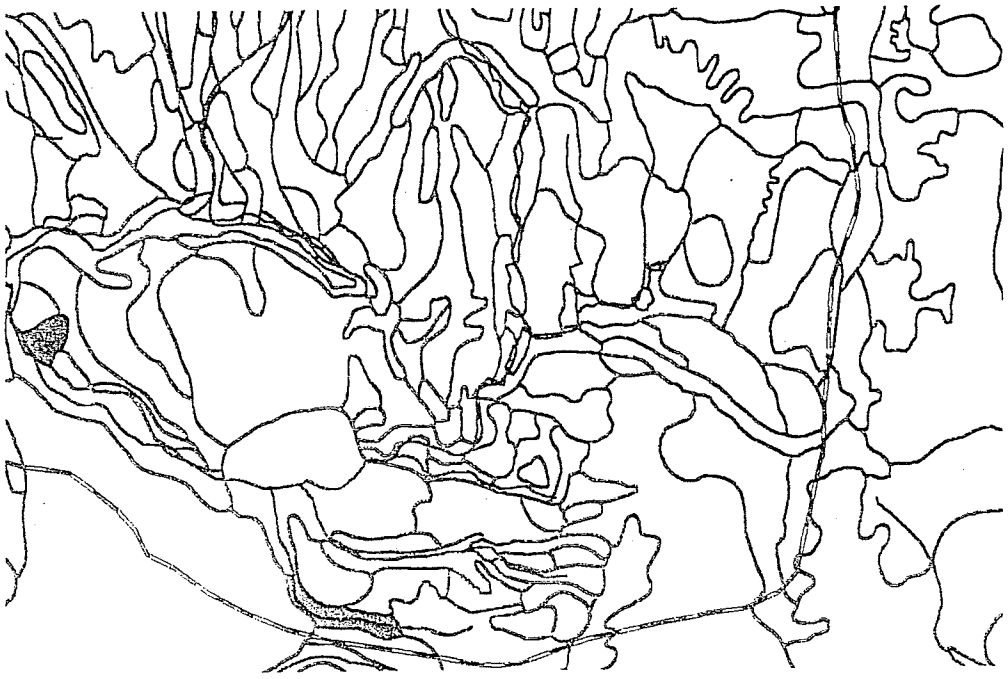
Indian Brook Watershed
Future Landuse

- 1200
- 1500
- 1600
- 1700
- 1730
- 2100
- 3000
- 4000
- 7000
- 7500

Figure 5.2: Indian Brook watershed 1995 actual land use; and future land use as defined by zoning designation.

Figure 5.3: Indian Brook generalized soils map.



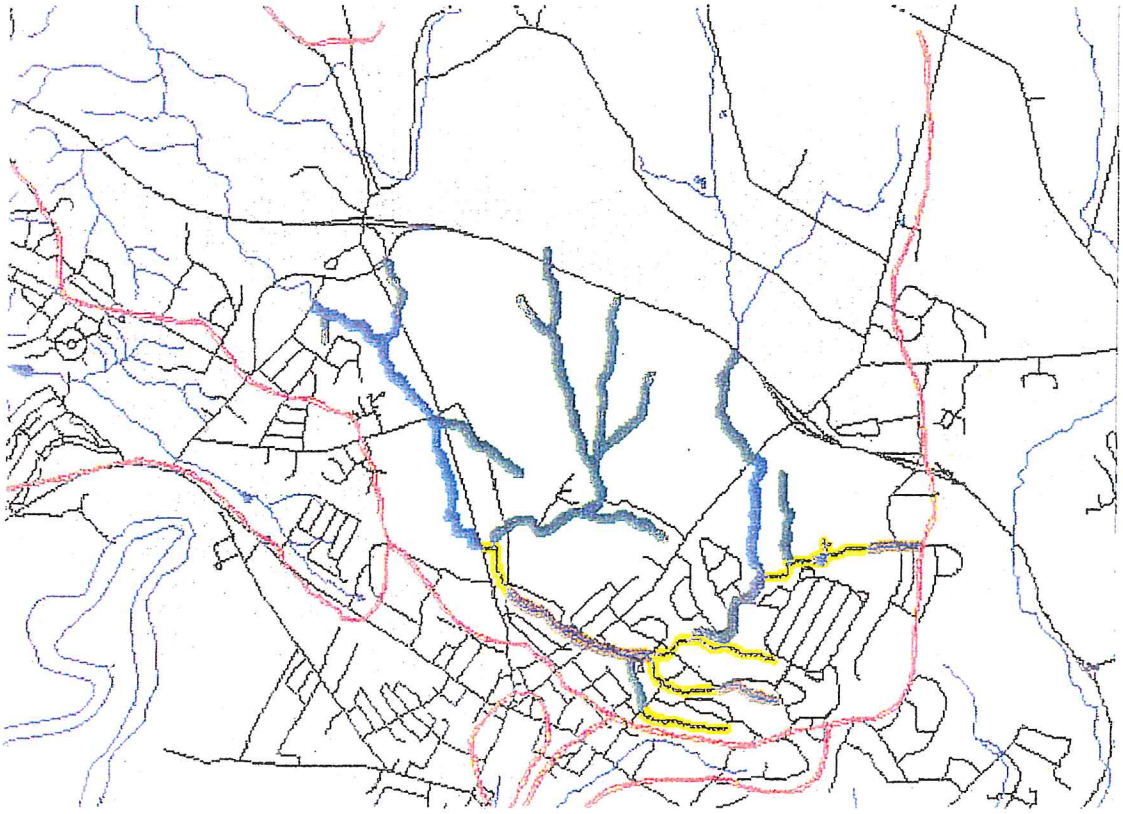


Indian Brook - Highly Erodible Soils

Figure 5.4: Indian Brook watershed - areas of highly erodible soils. These soils are easily displaced.

Indian Brook - Wetpond/Wetland Soils

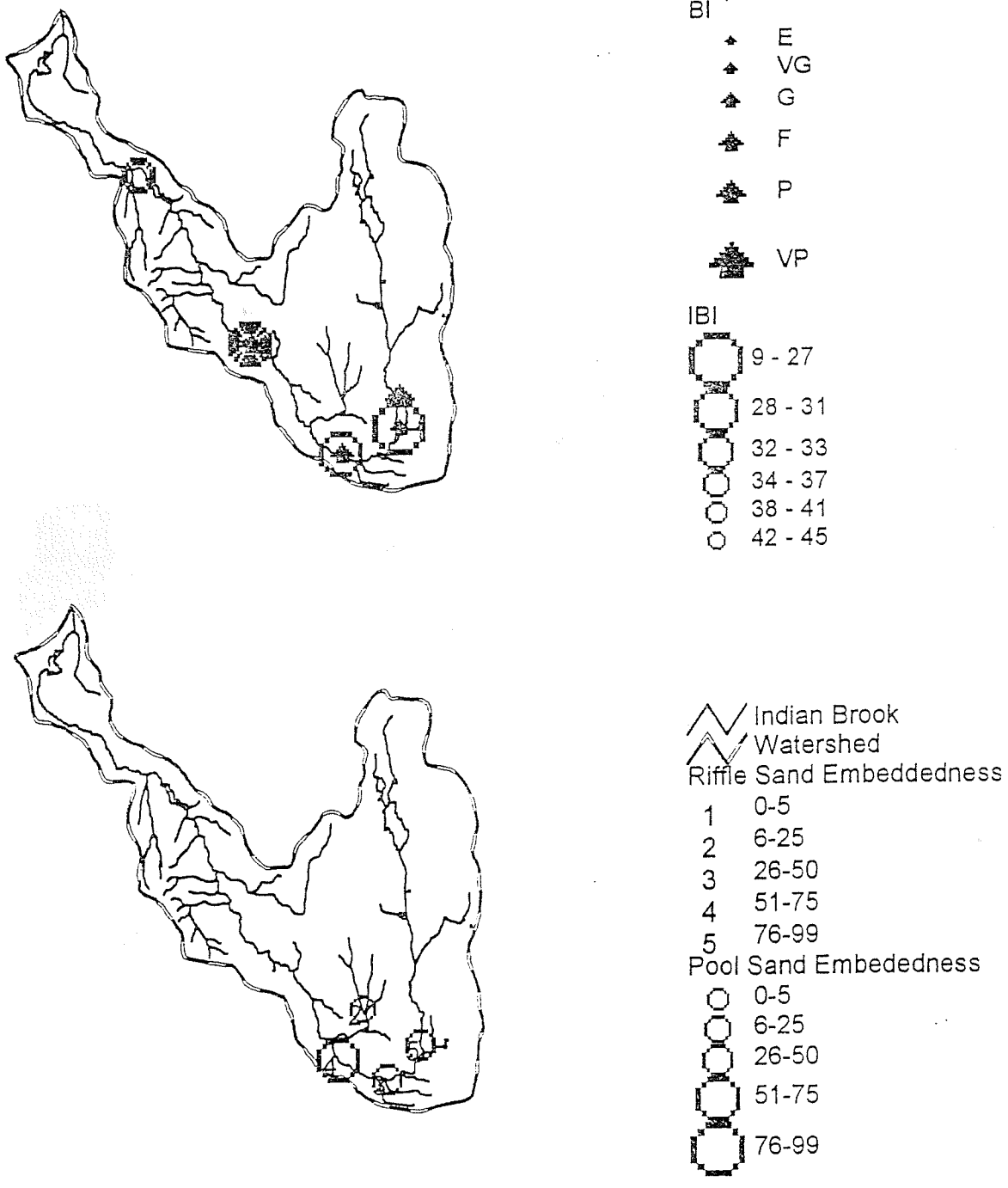
Figure 5.5: Indian Brook watershed - wetpond/wetland soils.



Riparian Corridor Evaluation (RCE)
Red=Poor, habitat structure gone
Brown=Fair, major habitat alteration
Yellow=Good, minor habitat alteration
Green=Very Good, monitor for changes
Blue=Excellent, protect existing status

Figure 5.6: Indian Brook Riparian Corridor Evaluation. Evaluation was conducted using the Riparian Corridor Evaluation methodology (Petersen, 1992). A series of measurements and observations are recording while walking the stream channel.

Figure 5.7: Indian Brook watershed - biological condition. Fish and macroinvertebrate community measures of integrity. A macroinvertebrate biotic index (BI) rating of less than good is indicative of sub-Class B condition. A fish Index of Biotic Integrity (IBI) rating of less than 31 is indicative of sub-Class B condition.



Watershed measure of pool and riffle sedimentation. A high degree of sand embeddedness indicates excessive erosion and impairs aquatic habitat and the biological communities that are supported by that habitat.

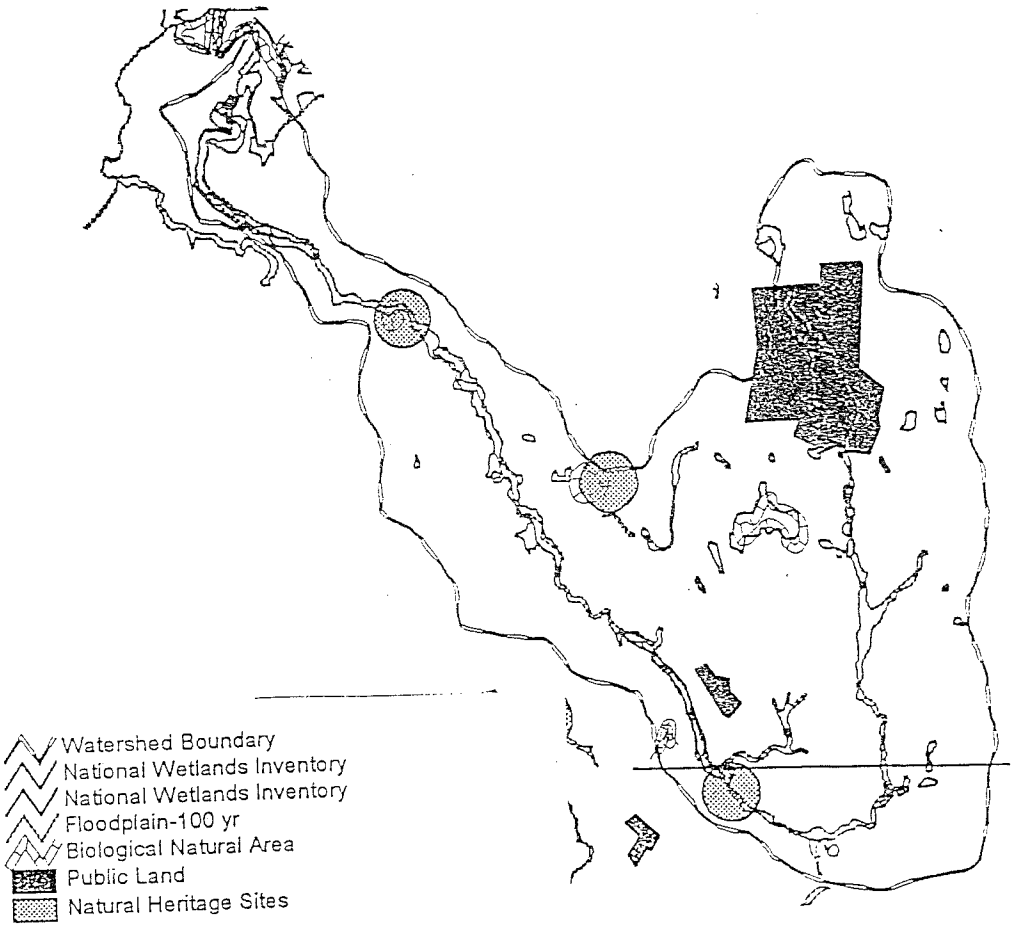


Figure 5.8: Indian Brook watershed - mapped wetlands, 100 yr. floodplain, biological natural areas, parks, and Natural Heritage sites.

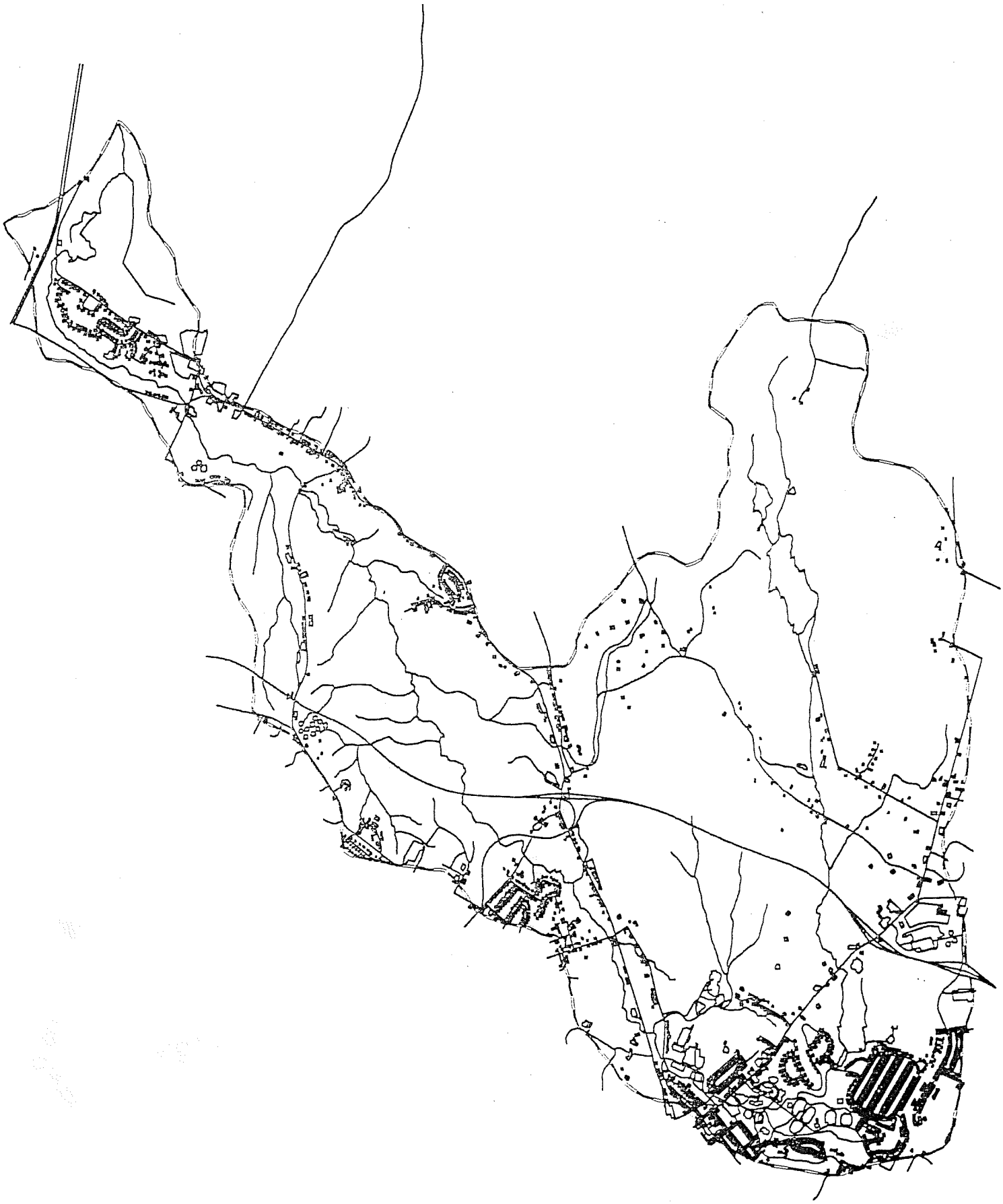


Figure 5.9: Indian Brook watershed mapped impervious surface - 1996.

Figure 5.10: Indian Brook watershed mapped sewersheds - 1996.

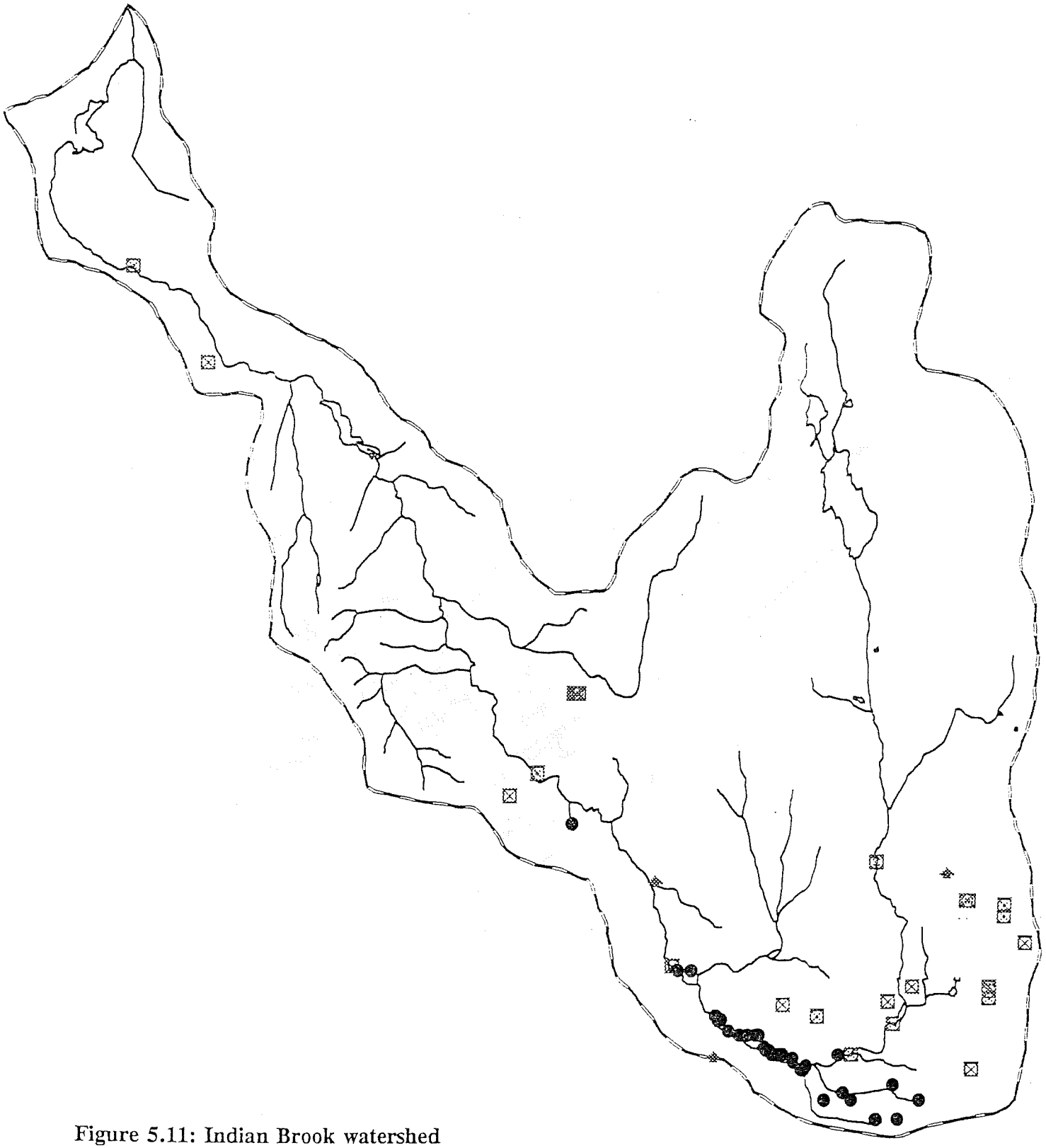


Figure 5.11: Indian Brook watershed mapped nonpoint sources. Mapped sources include: nonpoint sources such as eroding banks identified during RCE; stormwater permitted discharges; EPA hot landuses (quik-stops with gas pumps, gas stations).

Targeted Stormwater Sewersheds
Indian Brook Watershed

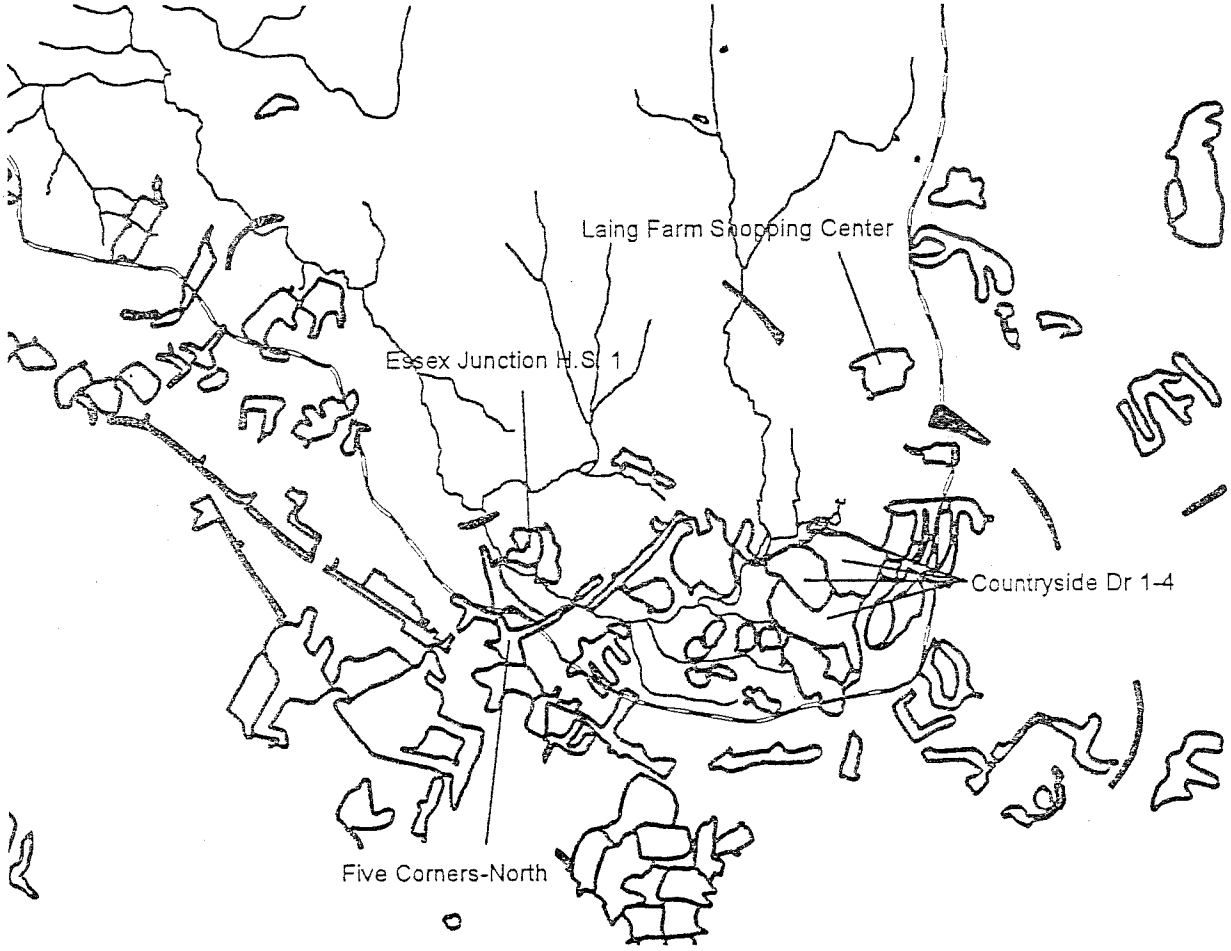
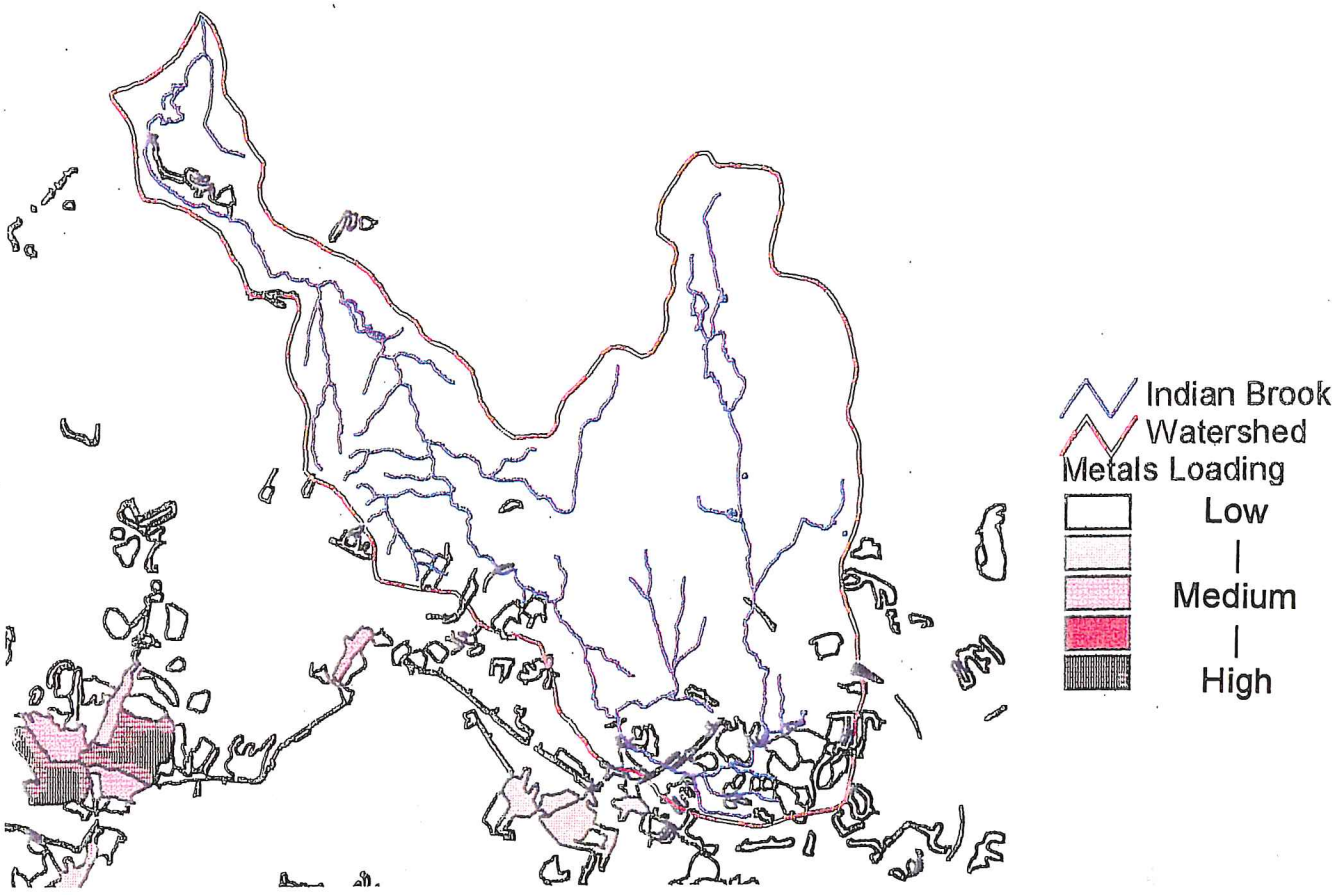


Figure 5.12: Targeted Stormwater Sewersheds in Indian Brook Watershed - Sewersheds were targeted based on exceedences of loading thresholds as described in Table 2.2. BMP recommendations are made for each targeted sewershed. Three sewersheds in the Indian Brook watershed have been targeted.

Figure 5.13: Estimated total suspended solids loading from sewersheds in the Indian Brook watershed.

Figure 5.14: Estimated total phosphorus loading from sewersheds in the Indian Brook watershed.



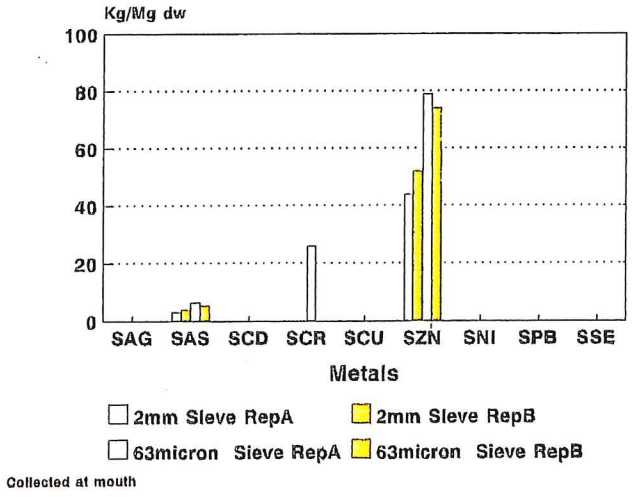


Figure 5.15: Estimated total metals loading from sewersheds in the Indian Brook watershed. Graph at bottom shows concentrations of metals in whole (2mm) and fine fraction (63u) sediments at the mouth of the Indian watershed. Samples collected in 1995.

Soils

- AdA
- AdA
- AdA - AdB
- AdB - AdD
- AdD - AdE
- AdE - Au
- Au - BlA
- BlA - Br
- Br - Cv
- Cv - DdA
- DdA - EwA
- EwA - FaC
- FaC - FaE
- FaE - FsB
- FsB - Fu
- Fu - HlB
- HlB - HlE
- HlE - HnB
- HnB - Le
- Le - Lf
- Lf - MuD
- MuD - MyB
- MyB - MyC
- MyC - Rk
- Rk - ScB
- ScB - TeE
- TeE - W
- W - Wo

Land Use 1995

- 0
- 1100-Residential
- 1130-Residential-Single Family
- 1190-Residential-Other
- 1200-Commercial
- 1230-Commercial Services
- 1250-Government
- 1252-Military
- 1260-Institutional
- 1270-Educational
- 1281-Museum
- 1300-Industrial
- 1330-Industrial-Stone
- 1370-Industrial-Mining
- 1373-Sand/Gravel
- 1400-Transportation
- 1410-Transportation-Air
- 1412-Transportation-Air
- 1440-Transportaiton-Road
- 1460-Utilities
- 1470-Utilities
- 1480-Utilities
- 1481-Utilities
- 1482-Utilities
- 1500-Industrial
- 1510-Industrial Park
- 1600-Mixed Use
- 1700-Outdoor Built
- 1720-Outdoor Built
- 1730-Outdoor Recreation
- 1734-Ski Area
- 1735-Golf Course
- 1736-Campground
- 1737-Parks
- 1740-Cemetaries
- 1790-Other outdoor built
- 2100-Cropland
- 2200-Orchards
- 2430-Other Agriculture
- 3000-Brush
- 3300-Mixed Brush-grass
- 4100-Broadleaf Forest
- 4200-Coniferous Forest
- 4300-Mixed Forest
- 5100-Rivers
- 5200-Lakes/Ponds
- 5210-Lakes/Ponds
- 6000-Wetlands
- 6100-Forested Wetland
- 7200-Beaches/River banks
- 7400-Exposed Rock

Future Landuse

- 1200-Commercial
- 1500-Industrial
- 1600-Mixed Use
- 1700-Outdoor Built
- 1730-Outdoor Recreation
- 2100-Cropland
- 3000-Brush
- 4000-Forest
- 7000-Growth Center
- 7500-Subregional Growth Center